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Abnormal Identification of Swine Flu Clinical Characteristics Based on Body Temperature and Behavior

Duo Wang¹, Ying Xu¹, Qifeng Liu¹, Yue Lou¹, Chaorong Luo¹ and Changji Wen¹(✉)

¹ College of Information and Technology, Jilin Agriculture University, Changchun, China
Chagou2006@163.com

Abstract. The pathology and virus isolation are the mainly diagnostic approaches for swine flu currently. Although the diagnosis rate is high, it is not conducive to detecting and intervening the infected pigs timely because of the serious time delay. Therefore, this paper proposed a novel framework method for the early detection and warned of swine influenza. The Jilin landrace are as the subjects of the experiment in this paper. Firstly, the body temperature changes were monitored compared between healthy and infected pigs respectively. And then the machine vision method was used to identify the basic pre-defined behavior of the landrace. Afterward, the behavior of the healthy and infected pigs were determined the abnormality or not. In the experiments, the results showed that the temperature of the infected pigs increased from 1 ~ 2 h to 40.3 ~ 41.5 °C and the lying status of the sick pigs was significantly increased compared to other activities such as feeding and drinking water. The experimental results showed that this method waseffective for early detection of swine flu.

Keywords: Swine flu; Activity recognition; Jilin landrace; body temperature

1 Introduction

Swine flu is a type of acute respiratory disease. It is caused by influenza A virus (influenza A virus). With the continuous expansion of large-scale pigs, swine flu poses a serious threat in recent years. It not only affects the quality of pork, but also affects the market supply seriously and demands to result in large swings in the price of pork. At the same time, some viruses are similar to those of human which are zoonoses viruses. The swine flu is seriously harm to the national economy and the health of residents.

The study of swine influenza has attracted much attention. How to study the rapid, scientific and accurate diagnostic method is of great significance to the surveillance and prevention of swine influenza. The study found that the clinical features of swine influenza generally manifested as several hours to several days, and the average time of onset was 4 days. At the beginning of the disease, the body temperature suddenly rise to 40.3 ~ 41.5 °C, the external behavior of anorexia or loss of appetite, often lying, shortness of breath, abdominal breathing, paroxysmal cough. Sick pigs

squeezed together, it is difficult to move [1,2]. The current diagnosis of swine influenza in addition to conventional clinical symptoms and pathological changes in diagnosis, mainly rely on laboratory diagnostic methods, by detecting the blood coagulation contained in the virus contains, and then determine the blood coagulation virus exclusion to achieve the diagnosis of swine flu .The swine influenza virus H1N1, H1N2 and H3N2 subtype multiple PCR diagnostic method is a more efficient and specific diagnostic method. It can be used for clinical rapid diagnosis and classification of samples [3,4,5,6]. The diagnostic methods such as pathology and virus isolation have higher diagnostic rate, but they have serious lag time, which is not conducive to timely detection and early intervention of infected pigs. Therefore, the use of abnormal changes in body temperature and the behavior of the clinical characteristics of live pigs have important research significance.

Clinical features were mainly through manual monitoring, but the traditional method of manual monitoring have a strong subjectivity, high labor costs, work intensity, fatigue and misdiagnosis rate and other issues. In order to overcome the drawbacks of manual monitoring methods, the rapid development and industrialization of the Internet of things what based on "perception" has gradually penetrated into all walks of life, and the development of the Internet of things included animal husbandry is also very rapid [7]. Domestic and foreign scholars use the Internet of things technology in the field of livestock monitoring to carry out extensive research. The method achieved satisfactory results which analyze the life signs of livestock specific stages and the recorded data of behavior by using data mining method [8,9,10,11,12]. The acquired data is through the three axis accelerometer and Bluetooth device sensors placed in different parts of the body parts of livestock. Other methods use the machine vision technology, the use of external camera device to obtain the external control of the target shape and movement of information flow, combine with artificial intelligence technology to achieve the semantic analysis and understand of image information. Machine vision technology has real-time, non-invasive, non-intrusive and so on, so in the field of agricultural cultivation and breeding have been sustained attention .It gradually become a hot spot in recent years [13,14,15,16,17,18].

In summary, through the analysis of relevant research reports at home and abroad concluded that the domestic and foreign research reports are very few by using Internet of things "perception" technology, monitoring the body temperature and detecting abnormal behavioral for early detection and warning of swine influenza. Therefore, this paper proposed a novel method by combining monitoring temperature and recognizing behavior on the basis of previous work, in order to achieve the temperature of infected pigs and abnormal behavior and summarize warning rules of the swine flu early.

2 Materials and methods

2.1 Experimental materials

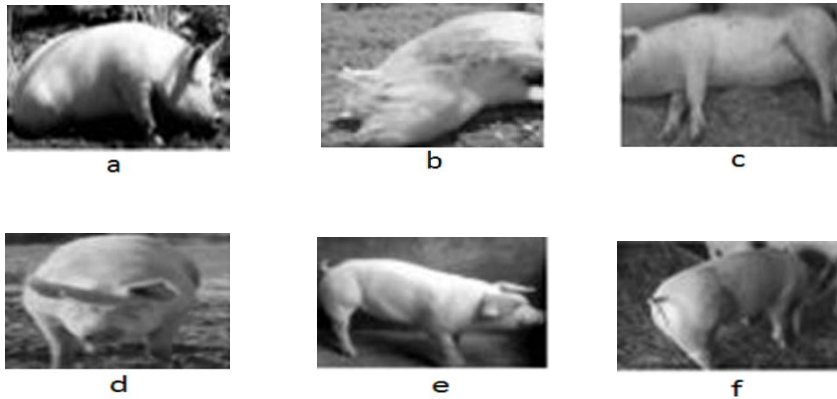
2.1.1 Experimental subjects

The samples, the Jilin Landrace, collected from Jifeng Pig Farm and COFCO Songyuan Pig Breeding Base in Jilin Province. The temperature was recorded in the period from 2013 to 2016 in the spring and autumn. Record the normal pigs 100 times, sick pigs only 70 times. Video collection of normal pigs only have 70 times, sick pigs have 20 times.

2.1.2 Experimental environment

Video capture platform includes, Panasonic WV-CP240 / G color CCD camera with a resolution of 752 pixels (horizontal) \times 582 pixels (vertical), Dahua DAHUADH-DVR0804LE-AS8 hard disk burner, back-end processor for ThinkStationP710 high performance Workstation, M4000 professional graphics, 64G memory, 512G Xeon E5-2630V4 dual CPU, the system software module using IMAQ Vision, the algorithm development platform for OpenCV.

Body temperature monitoring equipment using a self-test developed portable Bluetooth thermometer, including components, Sic -506F chip single-bus high-precision temperature sensor (0 ~ 50 °C range with \pm 0.01 °C accuracy, 0.004 ~ 0.034 °C signal resolution rate). HM06A Bluetooth module, using CSR BlueCore, TI CC2540 chip, configure 6 ~ 8 MB software storage space, support AT (attention) instruction. Lower machine STC15F2K60s microcontroller as the core processor, the host computer using VB programming. From the long-term video interception of the basic behavior of the video segment, the basic behavior, including lying, walking, arch, feeding and eating, behavior video capture single frame diagram shown in Figure 1.



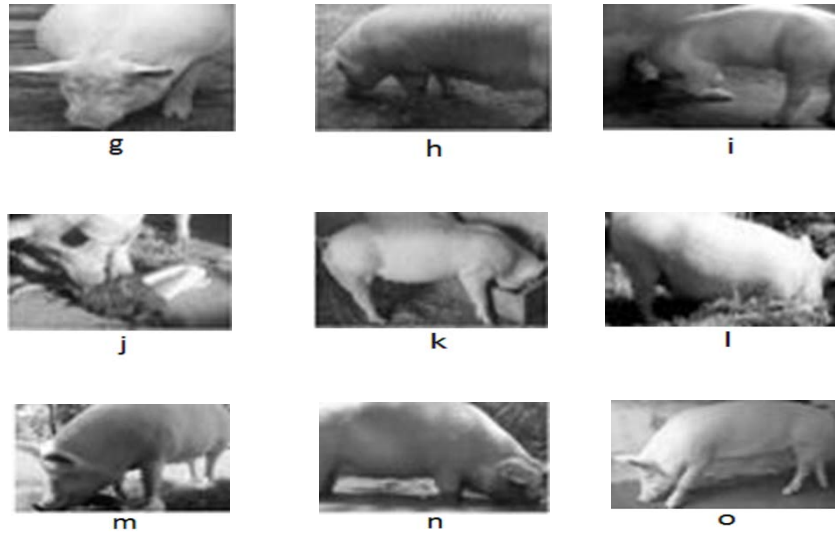


Fig. 1. Schematic diagram of the basic behavior

Note: Behavior Description:(a) lying on the front (b) lying on the side (c) lying on the back (d) walking front (e) walking side (f) walking behind (g) arch front (h) arch side (i) arch back (j) Feeding front (k) Feeding side (l) Feeding back (m) drinking water front (n) drinking water side (o) drinking water behind

2.2 Basic methods

According to the expert's experience and observation, the clinical characteristics of swine flu showed that the temperature of the swine was suddenly increased to 40.3 ~ 41.5 °C, the external behavior was anorexia or loss of appetite, frequent drinking water, continuous lying, Together, it is difficult to move. Therefore, monitoring the abnormal changes of body temperature and behavior of pigs are important bases for timely and effective detection of infected pigs. First, this study uses a self-developed Bluetooth body temperature measurement instrument, by wearing a home to monitor the ear root of pigs to record changes in the temperature of pigs, the analysis of normal pigs' body temperature compared with the sick pig in the whole course of abnormal changes in body temperature, and then combined with our previous works to use machine vision technology to achieve livestock behavior identification and understanding [18], by comparing the basic behavior of healthy pigs in the video revealed and finding abnormal behavior of diseased pigs. In order to judge and predict the prevalence of swine, it is on the basis of monitoring the abnormality of body temperature, behavior and its occurrence.

2.2.1 Bluetooth body temperature recorder

The Bluetooth body temperature recorder is made up of temperature sensors, micro-controllers, communication and storage units. It can be real-time monitoring of the

temperature through the signal stored in the storage unit, set the abnormal body temperature duration exceeds a certain threshold through the wireless Bluetooth way to monitor the temperature data sent to the PC side for recording analysis. Temperature sensor used TSic -506F chip, which the temperature sensor for a single bus high precision (0 ~ 50 °C range with ± 0.01 °C accuracy, 0.004 ~ 0.034 °C signal resolution). The host computer uses VC ++ programming, can carry out wireless real-time data transmission and inquiry through Bluetooth.

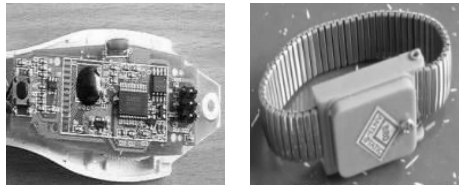


Fig. 2. Physical map of the Bluetooth body temperature recorder

Temperature sensor chip with T092 package, the temperature signal through the microstrip line and the motherboard link, the package after the temperature measurement parts into the rectangular rubber module, the package is soft and strong, the motherboard and the battery moisture proofing treatment, not only ensure good Heat conduction, but also cannot wear the skin pressure.

2.2.2 Video behavior recognition and understanding

We used the video recognition and understanding method, in order to realize the abnormal behavior discovery and recognition of the cow in the early work [18]. On the basis of this method, we also applied to the abnormal behavior identification and regularity of the pig. The implementation steps are as follows: The basic steps are as follows: (1) Video preprocessing, equal length segmentation of a given video segment (7 frames in this paper), using the training video segment (lying, walking, arching, feeding and eating) / Segment); (2) in the video segment to extract the spatial and temporal points of interest, the use of an improved space-time local binary model feature description of the spatial and temporal points of interest to extract the characteristics of the description [19,20,21]; (3) visual dictionary to achieve the video segment Feature description and representation, and use the trained classifier to achieve basic behavior recognition. Then, on the basis of accurate identification of the basic behavior, the specific test set is identified and understood. The following steps are as follows: (1) Video preprocessing, equal segmentation of a given video segment (7 frames / segment) Video segment feature description and representation, and the same steps in the previous step in the same way; (3) using the training classifier on the video segment semantic annotation, and according to the principle of video segment merging to achieve the recognition and understanding of the test video segment. One of the key technologies involves the following two points:

① to improve the space-time local binary model feature description operator, the specific expression is as follows:

$$MLBP-TOP = \begin{cases} 1 & g_{j,q}(x, y, t) \geq threshold \\ 0 & else \end{cases} \quad (1)$$

$$threshold = mean + a \bullet std, \quad a \in (0,1)$$

$$mean = \frac{\sum_{q=0}^p w_{j,q} \cdot g_{j,q}(x, y, t)}{p} \quad (2)$$

$$std = \sqrt{\sum_{q=0}^{p-1} (g_{j,q}(x, y, t) - \mu)^2}, \quad \mu = \frac{\sum_{q=0}^p g_{j,q}(x, y, t)}{p}$$

② video segment merging operator, the specific calculation of expression As follows:

$$Merge(v_i, v_{i-1} | v_{i+1}) = \begin{cases} v_{i-1} \oplus v_i & L(v_i) = L(v_{i-1}) \\ v_{i-1} \oplus v_i & L(v_i) \neq L(v_{i-1}) \wedge L(v_{i-1}) \neq L(v_{i+1}) \\ v_i \oplus v_{i+1} & \wedge L(v_{i-1}) = L(v_{i+1}) \\ v_i \oplus v_{i+1} & L(v_i) \neq L(v_{i-1}) \wedge L(v_i) = L(v_{i+1}) \\ v_i & L(v_i) \neq L(v_{i-1}) \wedge L(v_{i-1}) \neq L(v_{i+1}) \\ & \wedge L(v_{i-1}) \neq L(v_{i+1}) \end{cases} \quad (3)$$

Here, v_i the first segment of the initial segmentation video segment, said video segment belongs to the behavior category label, said video frame merge operation. The detailed algorithm implementation is described [18].

3 Experimental results and analysis

Experimental part have three groups of experiments, the first and second groups of experiments combined with expert knowledge, in which the experimental use of a Bluetooth thermometer to achieve healthy pigs and infected pigs in the body temperature monitoring and regular detection, experimental two use of pig basic behavior sample set. In the training literature [18], the behavior recognition model is used to realize the accurate identification of the basic behavior of live pigs. On the basis of the above methods, experiment 3 found that the abnormal expression of body temperature and behavior of diseased pigs was obtained, and the clinical characteristics of the disease were obtained and the feasibility of the early identification of swine flu was verified.

3.1 Experiment I: Monitoring abnormal body temperature

3.1.1 Experiment setting

The temperature of the swine was high in the spring and autumn of 2013-2020. The temperature of the thermometer was the position of the pig ear, and the non-contact infrared thermometer FLUKE-F59 was used in the ear root of the pig. During the recording method, the manual recording and the combination of the Bluetooth thermometer were recorded. During the period, 100 pigs were recorded for normal pigs. The time interval of normal recording time was 6h, and the time interval of recording was 0.5h. Sick pigs only 70 times. Manual recording time interval of 2h, Bluetooth thermometer recorder recording time interval of 0.5h.

3.1.2 Experimental results and analysis

First, to effectively verify the validity of the temperature measurement of the Bluetooth thermometer, we make two groups of comparative experiments, experimental (1) healthy pig temperature record comparison, due to the use of thermometer temperature recording time interval of 0.5h, manual records For the 6h, so in order to ensure the validity of the record data comparison, that is, manual mode and thermometer automatic recording method whether there is significant difference, the thermometer data selection corresponding to the manual recording time points before and after the four groups of data to take the mean comparison, Through ANOVA analysis and DUNCAN verification, it can be seen from Table 1 that there is no significant difference between thermometer measurement and manual measurement($P = 0.96 > 0.05$).

Table 1. different temperature measurement of significant significance

method	Average number	Standard deviation	Sample size	DUNCAN
thermometer	38.75	1.021	5000	A
artificial	38.74	1.043	5000	A

Experiment (2) We examined the body temperature of diseased pigs with the same test method. The results of the test were shown in Table 2, and there was no significant difference between the two methods.

Table 2. different temperature measurement of significant significance

method	Average number	Standard deviation	Sample size	DUNCAN
thermometer	40.95	1.041	5000	A
artificial	40.81	1.023	5000	A

In addition, no significant difference in the measurement results under different temperature measurement experiments verify the effectiveness of the temperature measurement of the Bluetooth thermometer. On this basis, the normal pig 100 times, and the sick pigs

70 times, using a thermometer to measure the normal and diseased pig body temperature contrast records shown in Figure 3, where the corresponding time point temperature data for the record data Take the mean.

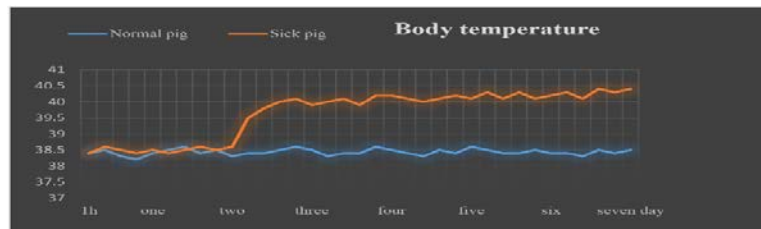


Fig. 3. Comparison of normal and diseased pigs with body temperature

The results showed that the temperature of healthy pigs was maintained between 38 °C and 39 °C during the period of temperature measurement, and the body temperature of the infected pigs jumped to above 40 °C after 1-2 hours after the incubation period of swine influenza virus, And in the onset cycle basically maintained at 40-42 °C . Therefore, when the pig body temperature abnormal fluctuations occur, you can use the thermometer to record the body temperature and make a warning based on fluctuations in body temperature.

3.2 Experiment II: Basic behavior recognition

3.2.1 Experiment setting

Video collection of healthy pigs 70 times, sick pigs 20 times, the two groups were the control group, the video collection were used alone feeding, sick pigs were isolated feeding. Video capture time is 6:00 - 8:00 pm, during this period of live pigs are more active, and to ensure that the video capture scene in the light of attention, sooner or later or cloudy artificial light source to fill the light operation, video capture effective time is 1400 hours. And then use the artificial pre-processing of the collected video, including the basic behavior of lying, walking, arching, feeding and drinking water, including the front, side and back of the video segmentation and artificial categories marked, respectively, to obtain five basic behavior In the front, side, back and random view training test samples of the 60 groups, a total of 1200 groups marked video samples, each video segment length of about 2 minutes, for the behavior identification model training.

3.2.2 Experimental results and analysis

First of all, for the 1200 group of training video, using 5 fold cross validation to take the mean way, the behavior recognition model of training and testing, specific training see the relevant literature [18]. Identify the results set up to confuse the matrix to illustrate, as shown in Figure 4.

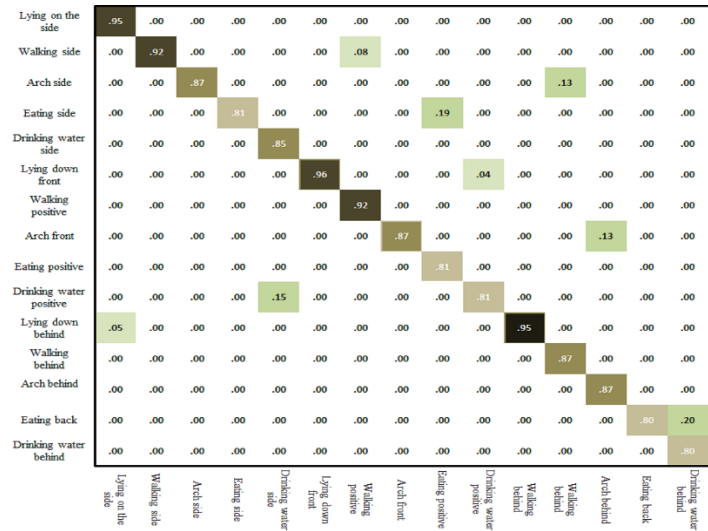


Fig. 4. The results of basic behavior recognition

The experimental results showed that the average recognition rate of lying and walking is 92.8%, which means that there are significant differences between the behavior and the performance of arch, feeding and drinking water. The average recognition rate of arch, feeding and drinking water was 83.2%, which was relatively low. The reason for the analysis was that the external morphological difference of the above behaviors was small and the misclassification was obvious. The results show that the average accuracy of the recognition model is 88.6% in the positive, lateral and posterior view.

3.3 Experiment III: Abnormal rules of temperature and behavior

On the basis of experiment one and two, we further found that the diseased pigs were abnormal in their body temperature and behavior.

3.3.1 Experiment setting

According to the field of animal medicine knowledge, Swine flu disease course are divided into latency, disease period, development period, peak period and recovery period, which latency clinical manifestations of the performance is less obvious implicit performance, the period in a non-infectious state. Sick 20 long white pigs the final diagnosis is still using the PCR method. From the experimental point of view specific screening basis for the selection and diagnosis of swine flu pigs with the feeding of pigs using PCR method for effective screening isolation feeding. During the incubation period, the temperature was recorded at 0.5 m intervals and the body temperature was recorded by effective screening. At the same time on the sick pig every day from 6: 00-18: 00 continuous video capture, sooner or later or cloudy arti-

cial light source to fill the light operation, select 7 of which effective video total length of 588 hours.

3.3.2 Experimental results and analysis

(i) abnormal rules of body temperature

First, the body temperature data of the pigs were recorded using a thermometer. We intercepted the virus infected swine flu pigs from health to illness and then to cure the body temperature data, the trend of body temperature changes shown in Figure 5. Healthy pigs are virus carriers after being infected by the virus, during which the incubation period, the onset period, the development period, the peak period and the full expectation. During the incubation period, the temperature of the body temperature is maintained at 38 °C -39 °C normal body temperature, the incubation period is about 1 day. After the rapid increase in body temperature to 40 °C -42 °C, that is, the duration of onset in 1-2 hours or so on. This body temperature lasts until about 4 to 6 days of healing. When the sick pig is cured, the body temperature will gradually decrease to normal body temperature. So accurate and accurate monitoring of abnormal temperature is important for pig disease early warning and further manual intervention.

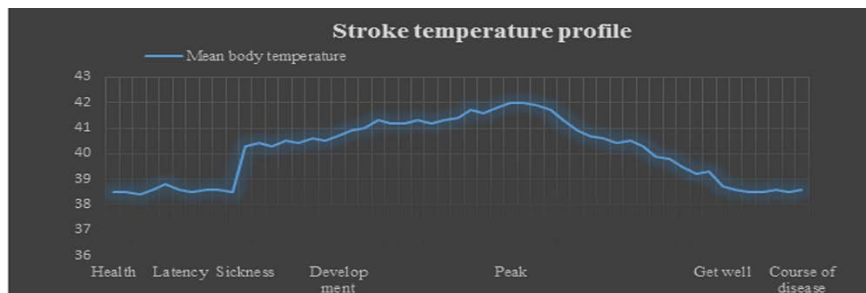


Fig. 5. course of body temperature trend chart

(ii) Abnormal rules of behavior

On the basis of experiment 2, the basic behavior of the diseased pigs in the video was identified by the trained behavior recognition model. The frequency of occurrence of a certain behavior in the unit time period was calculated at 3 hours as time unit, and the behavioral abnormalities Quantitative description of the law. At the same time, in order to verify the validity of the algorithm, the recognition result in the video is verified by manual verification, and the corresponding segment is marked in the figure, as shown in Fig. 6.

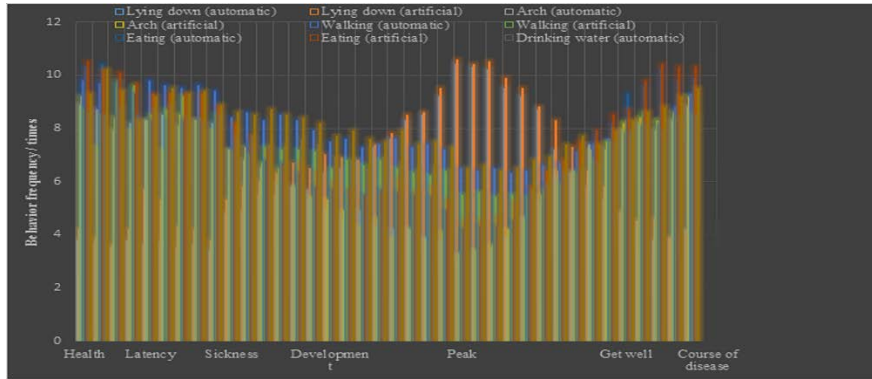


Fig. 6. Abnormal behavior frequency statistics results

The experimental results show that the results of this method are consistent with the results of artificial identification in the data trend of sick pig and normal pig lying, arch, walking, eating and drinking water, that is, after the disease is developed, Lying frequency significantly increased, arch, walking, eating and drinking behavior significantly reduced the number of times. The data show regular irregularity. Combined with artificial identification, sick pig lying behavior frequency has been increased. Arch, walking, eating and drinking water frequency has been reduced.

4 Conclusion

In this paper, the use of body temperature thermometer and machine vision method to achieve sick pig body temperature and behavior abnormalities of the discovery. First of all, the effectiveness of abnormal temperature monitoring of the thermometer was verified. Firstly, the temperature of the pigs was recorded by artificial and body temperature thermometer, and the validity of the thermometer was verified by statistical method. Secondly, the sick pig only to record the temperature and found abnormal changes in the prevalence of body temperature. Thirdly, through the basic behavior video training set training behavior recognition model, in order to further realize the disease in the video surveillance abnormal behavior to provide model method. Finally, combined with body temperature and behavior monitoring methods to achieve the abnormal rule of diseased pigs found. According to the temperature data found in the trend of changes in body temperature. That is in the incubation period and the onset of short-term temperature. Suddenly it jumped from the normal body temperature quickly increased to 40 °C -41 °C. Using the behavioral identification model, it was found that the prevalence of sick pigs in the video. It was significantly increased, and the other activities such as feeding and drinking water were significantly reduced. The experimental results show that the method can effectively realize swine influenza surveillance, and the automatic identification of swine flu clinical features is a useful supplement to the existing pathology analysis methods. This

method is one of great significance for the monitoring and early warning of swine flu and the timely provision of human intervention.

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